INTACT CAPTURE OF HYPERVELOCITY PARTICLES IN AEROGELS;
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The development of a suitable technique for collecting unmelted, intact micrometeoroids has been the object of research for several years.[1] One area that shows much promise is the use of silica aerogel as a capture medium. We have tested aerogels of different densities with varying degrees of success.

The experiment which we are reporting about was performed at the NASA Ames Vertical Gun Range. Glass spheres sorted into the 50 to 100 μm size range were launched at a speed of 4.99km s^{-1} into 0.05 g cm^{-3} aerogel. Previously we reported the results of our use of 0.15g cm^{-3} (hereafter 150mg) aerogel using new launch techniques.[2] Since then we have used aerogels with a density down to 0.05 g cm^{-3} (hereafter 50mg) and our new findings are quite exciting! One of the first things we notice upon inspection of the 50mg aerogel is the length of the resulting tracks. For particles in the 50 to 100 μm size range, the tracks range from 8 to 13mm in length, are straight and narrow and have what clearly appears to be intact spheres at the end. In the 150mg aerogel the tracks were typically 1.5mm long for 50 μm projectiles with particles at the end.[2] However, there were shorter tracks, skewed from the main tracks due to fragmenting of the projectiles, with smaller particles at the ends.

The optical quality of the aerogel is excellent and affords us the ability to make many good observations of the captured particles in the stereo optical microscope. Since our technique of impregnating the aerogels with low viscosity epoxy and grinding down to the particle[2] loses much of the information about the surface morphology of the recovered particles, a new technique was developed for removing the particles from the aerogel, washing them and mounting them for scanning electron microscope (SEM) analysis.

SEM observations of the surface morphology of the glass spheres confirms what we believed we saw in earlier cross-sections of glass particles in the 150mg aerogel. As the particle travels through the aerogel, it dynamically accretes a layer of aerogel. This aerogel is compressed and surrounds most of the particle (figure 1). This compressed layer of aerogel can be seen optically under certain incident lighting conditions and usually disappears in transmitted light. The accreted layer appears to be a consistent phenomenon and has been seen on all glass particles we have examined. From cross-sectional analyses of several particles the layer appears to generally range from around 1 to 10 μm in thickness. From observations using backscattered electrons, the accreted aerogel may be compressed to a density of one-half the glass. Further analysis using microtomed sections may be more useful in actually determining this quantity. The surface morphology of the exposed part of the glass spheres ranges from essentially smooth as in figure 1 to being covered with glass stringers, splashes and vesicles.

The glass sphere in figure 1 was potted in epoxy and sectioned and polished to examine the state of its interior (figure 2). The sphere appears to have survived completely intact. Unlike the glass spheres recovered in the 150mg aerogel which were fragments exhibiting varying degrees of fracturing and melting, this sphere shows no sign of alteration. The holes in the sphere are bubbles which are seen in almost all spheres, shot and unshot, and are certainly an artifact from the manufacturing process. Cross-sections of other spheres recovered in the 50mg aerogel are consistent with what we see here.

These new results imply that the lower density aerogels greatly enhance the survivability of an impactor. The dynamically accreted aerogel layer may actually protect the impacting particle and shield it from more destructive damage thus playing an important role in reducing particle degradation during capture.[2] We have examined one FeS particle recovered in 50mg aerogel. It appears to have survived greatly intact. The original state of the particle is unknown so it is hard to be conclusive about what we see at this time. Further work needs to be done with more realistic meteoroid analogs such as FeS and olivine to see how these will behave in 50mg aerogel. If our results for the glass spheres are indicative for what we can expect for other types of particles, then we have found a powerful technique for capturing low-velocity ($\leq$7km s^{-1}) micrometeoroids intact.

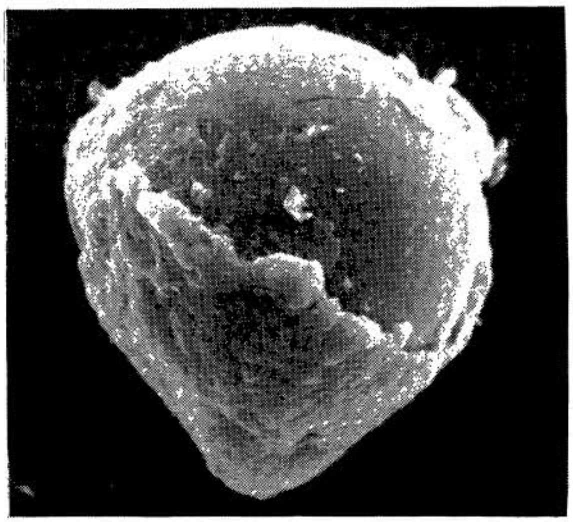

Figure 1. SEM image of a 55 μm glass sphere successfully decelerated intact from 4.99km s^{-1}. The cocoon that surrounds most of the particle is a dynamically accreted layer of compressed aerogel. This particle typically represents glass spheres captured in 50mg aerogel. Magnification is 1100×.

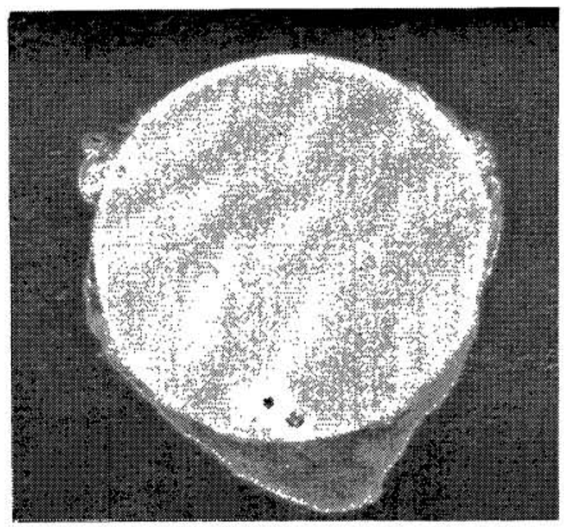

Figure 2. SEM image of the polished cross-section of the sphere in figure 1. The accreted aerogel layer ranges from 2 to 12 μm thickness. There are no cracks or fissures in this particle and the holes are bubbles which are present in almost all glass spheres. Magnification is 1100×.

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